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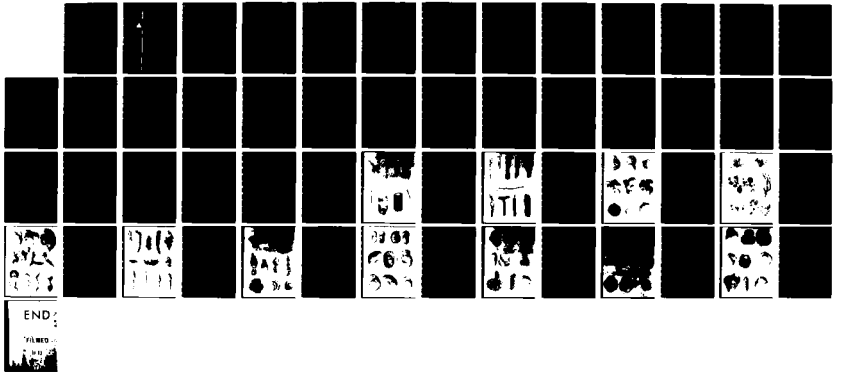

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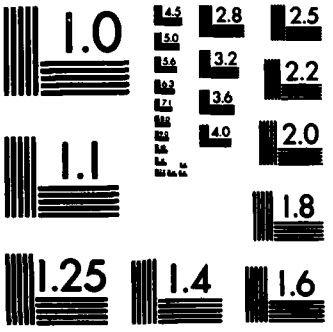

WHOI-83-35

Woods Hole Oceanographic Institution

Taxonomic Notes On The Abyssal Agglutinated Benthic Foraminifera Of The HEBBLE Area (Lower Nova Scotian Continental Rise)

by

M. A. Kaminski

September 1983

Technical Report

Prepared for the Office of Naval Research under Contract N00014-82-C-0019.

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Eighty species and morphological varieties of agglutinated benthic foraminifera were identified in sediments from the HEBBLE Site (4800 m depth) and the HEBBLE Shallow Site (4185 m) on the lower Nova Scotian Continental Rise. Details of their morphology and classification are included in descriptions of each species, and representative specimens are illustrated using SEM, light microscopy, and X-radiography.

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2. Continental Rise
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Approved for Distribution:

R. P. Von Herzen

Richard P. von Herzen, Chairman
Department of Geology and Geophysics

ABSTRACT:

Eighty species and morphological varieties of agglutinated benthic foraminifera were identified in sediments from the HEBBLE Site (4800 m depth) and the HEBBLE Shallow Site (4185 m) on the lower Nova Scotian Continental Rise. Details of their morphology and classification are included in descriptions of each species, and representative specimens are illustrated using SEM, light microscopy, and X-radiography.

INTRODUCTION:

In 1982 and 1983 a total of 48 box cores were collected at the HEBBLE (High Energy Benthic Boundary Layer Experiment) site, using a 0.25m^2 corer (Hessler and Jumars, 1974). The HEBBLE site is located on the lower continental rise off Nova Scotia centered at (40° 27'N, 62° 20'W) at approx. 4815 - 4830 m water depth. On a large scale, this region is influenced by intermittently strong bottom currents capable of resuspending sediments. The predominant water mass at the site is NADW, with periodic influence of AABW. On KNORR Cruise 103 (June, 1983), one box core was taken from a site designated the Hebble Shallow site (40° 53'N, 63° 44'W) at a depth of 4185 m. These samples will serve as a basis for comparing the fauna of a relatively quiet region with those of the primary HEBBLE site. The locations of both sites are shown in Fig. 1.

On KNORR Cruise 96 (July 1982), the top sediment layer from twenty-one box cores was sampled at 0-1mm, 1-5mm, and 5-20mm depth for analysis of particle size. The 0-1mm sample was obtained by gently oscillating sea water across the core surface to resuspend mobile surface particles, and picking up the resuspended material with a syringe. 1-5mm and 5-20mm layers were sampled by scraping the core surface with a spatula to the appropriate depth. On KNORR 101 (April, 1983) and 103, samples were taken from each core from the 0-1 cm. surface layer. Deeper samples were obtained from split Knorr 96 subcores using a plastic hypodermic syringe inserted into the sediment to give 10cc subsamples. All samples were gently washed without dispersant through a 63μm screen. Foraminifera were picked from the >250 and 63-250 μm size fraction splits, and individual specimens photographed on SEM and in reflected light.

This report deals specifically with the taxonomy of the agglutinated foraminifera of the lower Nova Scotian Continental Rise. Environmental data obtained from samples and spatial variation of agglutinated species will be published separately.

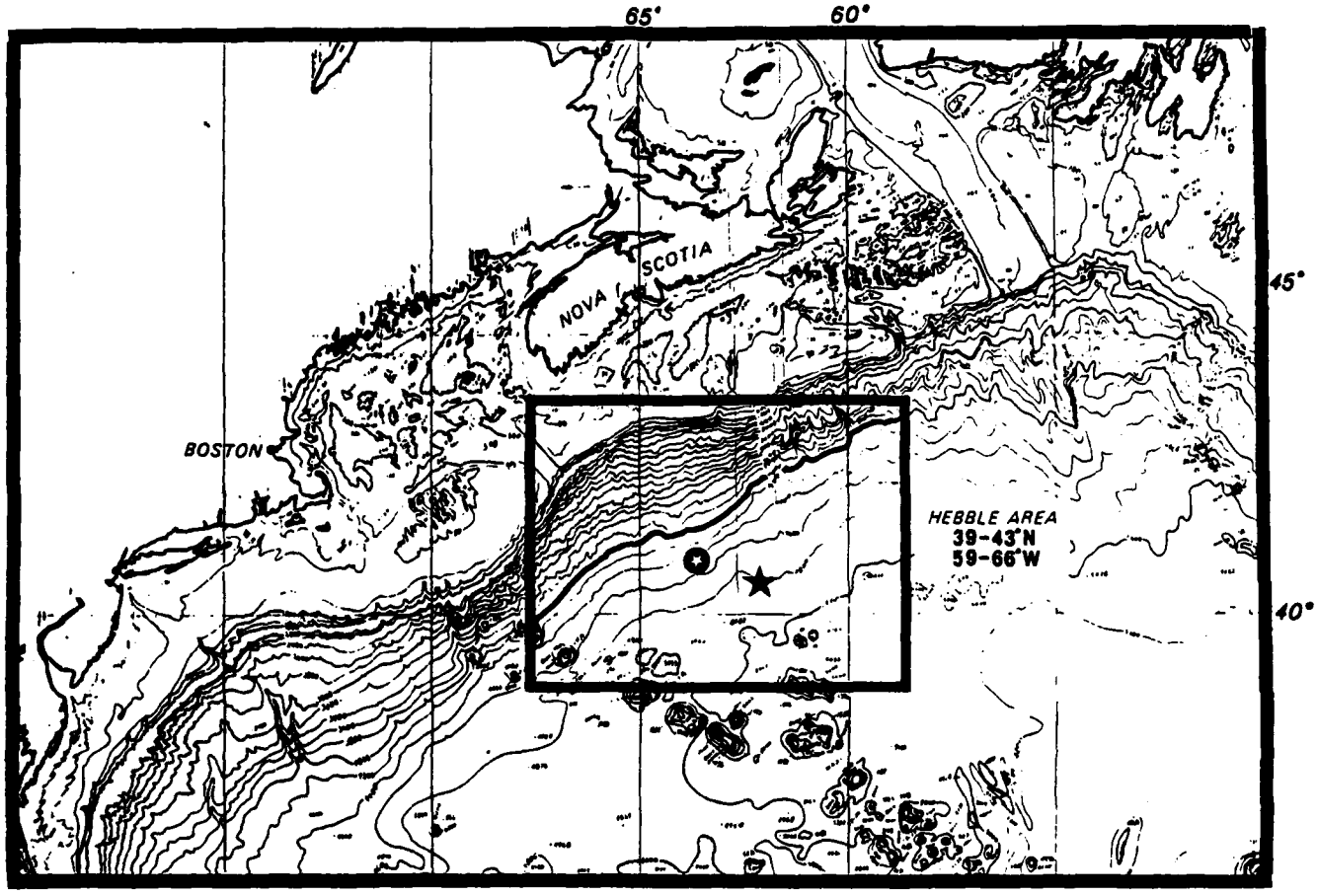

Fig. 1. Map showing location of HEBBLE Area (after Hollister et al. 1980, with modifications.)

★ - HEBBLE Site

● - HEBBLE Shallow Site

TAXONOMY:

Deep water agglutinated foraminifera from the North Atlantic have been studied by numerous workers for over a century. Brady's (1884) comprehensive work, revised by Barker (1960) is still widely used as a basis for taxonomic study. Other classic works include Goës (1894), Cushman (1918, 1920, 1922), and Höglund (1947). More recently, Cole (1981) illustrated species from the Newfoundland continental shelf and slope, Todd and Low (1981) figured forms from the N.E. United States continental shelf, and Gooday (1983) illustrated species from the NE Atlantic. Useful taxonomic treatments of recent deep water agglutinated foraminifera from other regions include Earland (1933, 1934, 1936), Echols (1971), Hofker (1972, 1976), Saidova (1975), Tendal and Hessler (1977), Lukina (1980), Ingle et al. (1980), Milam and Anderson (1981), Poag (1981), and Resig (1981).

On the basis of morphology, modern deep-water agglutinated foraminifera can be sub-divided into 7 general taxonomic groups:

1. Bush- or bead-like forms made of clay (Komokiidae and Baculellidae).....p.12.
2. Tubular forms, branched or unbranched (Astrorhizidae).....p. 5.
3. Single-chambered forms (Saccamminidae).....p. 9.
4. Single coiled tubes (Ammodiscidae).....p.11.
5. Multilocular uniserial forms (Hormosinidae).....p.13.
6. Bi- and triserial forms (Textulariidae).....p.20. (also Textulariopsidae, Spiroplectamminidae, Valvulinidae, and Ataxophragmiidae)
7. Multilocular coiled forms (Lituolidae, Loftusiidae, and Trochamminidae).....p.17.

The suprageneric classification currently in use by most workers is that of Loeblich and Tappan (1964). However, in recent years profound changes have been made in the classification of Foraminifera. Scores of new genera have been created, and one new superfamily, the Komokiacea, was described (Tendal and Hessler, 1977). Saidova (1981) proposed

a new suprageneric classification scheme that has not gained wide acceptance. More recently, Loeblich and Tappan (1982a) published an outline of a suprageneric classification scheme which features modified latin endings for superfamilies, and incorporates many newly erected genera. This scheme was later modified by Loeblich and Tappan (1982b). Loeblich and Tappan (1982c) proposed a revised suprageneric classification, in which the original superfamily endings were retained. This classification contains 13 superfamilies and 52 families in the suborder Textulariina, compared with 3 superfamilies and 16 families in Loeblich and Tappan (1982a). In a revision of the Trochamminacea, Brönnimann et al. (1983) modified Loeblich and Tappan's (1982c) scheme. The anticipated publication of an updated treatise by Loeblich and Tappan will no doubt synthesize recent changes in the classification of Foraminifera.

Since Loeblich and Tappan (1983c) do not list the genera contained within individual subfamilies, I have classified species according to the scheme of Loeblich and Tappan (1982a) with minor modifications. Taxonomic problems abound at the species level even among well-established taxa. I have taken a conservative taxonomic approach and describe several forms using open nomenclature. Notes of recent generic classification changes appear in the species descriptions.

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SYSTEMATIC PART

Class GRANULORETICULOSA Deflandre in Gresse, 1953
Order FORAMINIFERIDA Eichwald, 1830
Suborder ALLOGROMIINA Loeblich and Tappan, 1961
Superfamily LAGYNACEA Schultze, 1854
Family ALLOGROMIIDAE Rhumbler, 1904

Placopsilinella aurantica Earland.
Pl. 11, fig. 8

Placopsilinella aurantica Earland, 1934. Discovery Reports, vol. 10, p. 95 pl. 3, fig. 18. Echols, 1971 pl. 1, fig. 1.
Small, chitinous, bright reddish-brown species attached to planktonic foraminifer tests.

Superfamily AMMODISCOIDEA Reuss, 1862
Family ASTRORHIZIDAE Brady, 1881

?Astrammina sphaerica (Heron-Allen and Earland) var.
Pl. 1, fig. 1

Armorella sphaerica Heron-Allen and Earland, 1932. Roy. Micr. Soc. Jour., ser. 3, vol. 52, pt. 3, art. 10, p. 257, pl. 2, figs. 4-11.
Armorella was listed as a synonym of Astrammina by Loeblich and Tappan (1964), but retained by Hofker (1972) who maintains it differs from the latter in possessing a test built of a single layer of sand grains. Specimens are large, brown in color with globular central chamber and 3 - 6 tubular arms not in one plane. Firmly cemented test comprised of one layer of sand grains. May incorporate large sand grains and occasionally planktonic foraminifera. Differs from the typical form in the larger dimensions of the tubular arms.

Rhabdammina cf. abyssorum Carpenter
Pl. 1, fig. 2

Rhabdammina abyssorum Carpenter, 1869 Roy. Soc. London, Proc. vol. 18,

no. 4, p. 60. Milam and Anderson, 1981 pl. 1, fig. 1.
Test rectilinear, open at both ends, reddish brown in color, slender, up to 5 mm long, firmly cemented, comprised of quartz grains, exterior roughly finished. Distinguished from H. cylindrica by its rough texture, darker color and lack of mafic grains.

Rhabdammina discreta Brady

Pl. 1, fig. 3

Rhabdammina discreta Brady, 1881 Quart. Jour. Micro. Sci., vol. 21, p. 48. Barker, 1960 pl. 22, figs. 7-10.
Test straight, thicker than R. abyssorum, comprised of mud and sand with some mafic grains, firmly cemented.

Rhabdammina linearis Brady

Pl. 1, fig. 4

Rhabdammina linearis Brady, 1879 Quart. Jour. Micr. Sci., vol. 19, p. 37. Milam and Anderson, 1981 pl. 1, fig. 1.
Test robust, straight, with swollen central chamber.

Rhizammina cf. algaeformis Brady

Pl. 1, fig. 5

Rhizammina algaeformis Brady, 1879 Quart. Jour. Micr. Sci., vol. 19, p. 39, pl. 4, figs. 16,17. Cushman, 1918 pl. 11, figs. 2, 3.
Test thin, comprised of mud with or without agglutinated small planktic foraminiferal tests, loosely cemented, friable, flattened.

Rhizammina indivisa Brady

Pl. 1, fig. 6

Rhizammina indivisa Brady, 1884 Rep. Voy. Challenger. Zoology, vol. 9, p. 277, pl. 29, figs. 5-7. Cushman, 1918 pl. 12, figs. 7-10.
Test cylindrical, robust, with chitinous lining, composed of mud with small planktonic foraminiferal tests, more firmly cemented than R. algaeformis.

Bathysiphon cf. filiformis M. Sars

Pl. 1, fig. 7

Bathysiphon filiformis M. Sars, 1872 Vidensk.-Selsk. Christiana, Forhandl. 1872, p. 251. Ellis and Messina, Catalogue of Foraminifera.
Test robust, flexible, reaching a length of 14 mm. Wall smooth, comprised of clay with no constrictions.

Bathysiphon cf. rufescens Cushman

Pl. 1, fig. 8

Bathysiphon rufescens Cushman, 1917 U.S. Nat. Mus. Proc. vol. 51, no. 2172, p. 651. Ellis and Messina, Catalogue of Foraminifera.
Test long (up to 6 mm), slender, gently curved. Wall yellow-orange in color, with mafic grains. Differs from typical B. rufescens in its lack of constrictions.

Marsipella cylindrica Brady

Pl. 2, fig. 1

Marsipella cylindrica Brady, 1882 Roy. Soc. Edinburgh Proc. vol. 11, p. 714. Milam and Anderson, 1981 pl. 1, fig. 3.
Test thin, elongate, with organic lining. Wall comprised of fine sand with a considerable amount of long, slender sponge spicules oriented parallel to the test.

Hyperammina cylindrica Parr

Pl. 2, fig. 2

Hyperammina cylindrica Parr, 1950. B.A.N.Z. Antarctic Res. Exped. 1929 - 1931 Reports, ser. B, vol. 5, pt. 6, p. 254, pl. 3, fig. 5. Ellis and Messina, Catalogue of Foraminifera.
Test thin, elongate, with subglobular proloculum greater in diameter than second chamber. Wall comprised of fine sand grains, yellowish brown in color with mafic grains.

Hyperammina elongata Brady

Pl. 2, fig. 3

Hyperammina elongata Brady, 1878 Ann. Mag. Nat. Hist. ser. 5, vol. 1, p. 433, pl. 20, figs. 2a,b. Barker, 1960 pl. 23, fig. 8.

Test thick, elongate, with subglobular proloculum greater in diameter than second chamber, which tapers towards distal end. Wall comprised of fine sand grains. Larger in size than H. cylindrica.

Hyperammina friabilis Brady

Pl. 2, fig. 4

Hyperammina friabilis Brady, 1884 Rep. Voy. Challenger. Zoology, vol. 9, p. 258, pl. 23, figs. 1-3, 5, 6. Barker, 1960 pl. 23, figs. 1-3, 5, 6.
Test large. Wall thick, composed of fine sand with some coarse particles.

Hyperammina cf. subnodosa Brady

Pl. 2, fig. 5

Hyperammina subnodosa Brady, 1884 Rep. Voy. Challenger. Zoology, vol. 9, p. 259, pl. 23, figs. 11-14.
Test robust, wall thick with coarse quartz grains and sponge spicules, no inner lining, loosely cemented. Differs from the typical H. subnodosa in its more coarsely arenaceous test.

Hyperammina sp.

Pl. 2, fig. 6

Very fine, fragile, rectilinear tube with globular proloculus comprised of clear-white quartz grains.

Botellina labyrinthica Brady

Pl. 2, fig. 10

Botellina labyrinthica Brady, 1884 Rep. Voy. Challenger. Zoology, vol. 9, pl. 29, figs. 8-18. Barker, 1960 pl. 29, figs. 8-18.
Test grey in color, wall thick, comprised of very fine silt grains, loosely cemented. Interior labyrinthic with organic lining. Wall finer grained than Brady's material.

Dendrophrya arborescens (Norman)

Psammatodendron arborescens Norman, 1881 Norpod.-Exped. inder Jahren 1872 - 1874, vol. 13, p. 98.
Very fine, delicate bifurcating tube comprised of fine sand grains.

Saccorhiza ramosa (Brady)

Pl. 2, fig. 7

Hyperammina ramosa Brady, 1879 Quart. Jour. Micr. Sci. vol. 19, p. 33, figs. 14, 15.

Saccorhiza ramosa (Brady). Cole, 1981 pl. 1, fig. 5.

Specimens are curved, rather coarsely agglutinated, with a moderate amount of sponge spicules oriented normal to the test.

?Saccorhiza sp.

Pl. 2, figs. 8, 9

Test fragile, comprised of long, diachotomously branching tube closed at one end. Closed end not wider than ensuing tubular portion. Wall is tan in color, built of 2 or 3 layers of fine quartz silt grains with little cement. Black organic lining often collapses and pulls away from inner surface of rigid wall. Diameter of tube: 0.21 - 0.27 mm; Thickness of wall: 0.03 mm.

Family SACCAMMINIDAE Brady, 1884

Psammosphaera cf. fusca Schulze

Pl. 3, figs. 1,2

Psammosphaera fusca Schulze, 1875 II Jahr. Comm. Wiss. Unt. deutsch Meer in Kiel. p. 113, pl. 2, figs. 8a-f.

Test coarsely finished, brown in color, may incorporate larger mineral grains (pseudoattached). Wall a single layer of sand grains.

Psammosphaera parva Flint

Pl. 3, fig. 3

Psammosphaera parva Flint, 1899 Ann. Rep. U.S. Nat. Mus., 1897, pt. 1, p. 268, pl. 9, fig. 1. Mendelson, 1981 pl. 2, 3.

Test free or pseudo-attached, resembling P. cf. fusca except built around a single long sponge spicule. Wall comprised of a single layer of sand grains, reddish brown, firmly cemented.

Psammosphaera testacea (Flint)

Pl. 3, fig. 6

Psammosphaera fusca var. testacea Flint, 1899 Ann. Rep. U.S. Nat. Mus., 1897, pt. 1, p. 268, pl. 8, fig. 2. Cushman, 1918 pl. 15, figs. 1, 2.
Test comprised of tests of small planktonic foraminifera.

Psammosphaera sp.

Pl. 3, figs. 4, 5

Test variable in composition, usually comprised of several large angular quartz grains agglutinated by fine quartz silt. Fine-grained portion yellow in color. May possess one or two planktonic foraminifera incorporated into the test.

Saccammina sphaerica G.O. Sars

Pl. 3, fig. 7

Saccammina sphaerica G.O. Sars, 1872 Forhandl. Vidensk.-Selsk. Christiania 1872. p. 250. Barker, 1960 pl. 18, fig. 12.
Test delicate, monolocular with aperture on a produced neck. Wall brown, finely agglutinated.

Saccammina sphaerica G.O. Sars var. catenulata Cushman

Saccammina sphaerica Brady var. catenulata Cushman, 1917 U.S. Nat. Mus. Proc. vol. 51, p. 652. Cole, 1981 pl. 3, fig. 1.
Specimens are pseudo-attached to large sand grains

Saccammina tubulata Rhumbler

Pl. 3, fig. 8

Saccammina tubulata Rhumbler, 1931 in: Drygalski, 1931 Deutsche Sudpolar Expedition 1901-1903 Bd. 20, pl. 23. Resig, 1981 pl. 9, fig. 5.
Test free or pseudo-attached, coarsely agglutinated with long, delicate, finely agglutinated neck.

Thurammina papillata Brady

Pl. 3, fig. 9

Thurammina papillata Brady, 1879 Quart. Jour. Micr. Sci. vol. 19, p. 45, pl. 5, figs. 4-8. Barker, 1960 pl. 36, figs. 7, 13.

Fragile species often flattenned, brown in color, with multiple apertures. Finely agglutinated fragile test.

?Lagenammina difflugiformis (Brady) var. calcarea Cushman

?Lagenammina ?difflugiformis (Brady) var. calcarea Cushman, 1947 Cush. Lab. Foram. Res. Contr. vol. 23, p. 86, fig. 16

Test small, longer than wide, comprised of calcareous and clear-white quartz grains. Lukina (1969) erects the genus Proteonella for such pear-shaped monolocular forms.

Family AMMODISCIDAE Reuss, 1862

Glomospira charoides (Jones and Parker)

Pl. 5. fig. 1

Trochammina squamata charoides Jones and Parker, 1860 Geol. Soc. London, Quart. Jour., vol. 16, p. 304.

Glomospira charoides (Jones and Parker). Poag, 1981 pl. 7-8, fig. 4.

Small, very rare - found in one sample.

Glomospira gordialis (Jones and Parker)

Pl. 5, fig. 4

Trochammina squamata gordialis Jones and Parker, 1860 Geol. Soc. London, Quart. Jour., vol. 16, p. 304.

Glomospira gordialis (Jones and Parker). Resig, 1981 pl. 9, fig. 12.

Found occurring with G. charoides.

Ammolagena clavata (Parker and Jones)

Trochammina irregularis var. clavata Parker and Jones, 1860 Quart. Jour. Geol. Soc. vol. 16, p. 304.

Ammolagena clavata (Parker and Jones). Lukina, 1980 fig. 31.

Test attached (pseudo-attached) to Globorotalia menardii.

Suborder TEXTULARIINA Delage and Herouard, 1896
Superfamily KOMOKIACEA Tendal and Hessler, 1977
Family KOMOKIIDAE Tendal and Hessler, 1977

Septuma ocotillo Tendal and Hessler.
Pl. 4, fig. 1

Septuma ocotillo Tendal and Hessler, 1977. Galathea Rep. vol. 14, p. 180, pl. 9, fig. C, pl. 10, figs. A,B, pl. 12, figs. A,B, pl. 19, fig. A, pl. 20, figs. A-F, pl. 21, figs. A-D.
Test bush-like, branching out irregularly from the base. Wall comprised of tan-colored clay with an organic lining.

Septuma sp.
Pl. 4, figs. 3, 4

Test large, bush-like, flexible. Tubules flattened, with constrictions, branching out from the basal portion. Wall made of tan-colored clay and coccolith debris with some small fragments of planktonic foraminifera over a darker organic lining.

Lana reticulata Tendal and Hessler
Pl. 4, fig. 2

Lana reticulata Tendal and Hessler, 1977. Galathea Rep. vol. 14, pp. 186-187. pl. 14, figs. A-C, pl. 19, fig. C.
Specimen comprised of fine, branching tubules with no focal point of symmetry. Wall tan colored clay.

Lana sp.
Pl. 4, figs. 5, 6

Tubules are thicker than in Lana reticulata, and comprised of fine silt sized quartz particles over a dark inner organic lining. Attached to planktonic foraminifera and other debris.

Superfamily LITUOLOIDEA de Blainville, 1825
Family HORMOSINIDAE Haeckel, 1894

Aschemonella scabra Brady

Pl. 5, figs. 3, 4

Aschemonella scabra Brady, 1879 Quart. Jour. Micr. Sci. vol. 19, p. 44, pl. 3, fig. 12, 13. Barker, 1960 pl. 27, figs. 1, 2, 4-11.
Test several millimeters in size, with several openings. Test wall comprised of fine sand several grains thick with occasional small planktonic foraminiferal tests. Type species for Aschemonella. Large number of fragmentary specimens found in one sample. Gooday (1983) speculates this species is a Xenophyophore.

Aschemonella ramuliformis Brady

Pl. 5, figs. 5, 6

Aschemonella ramuliformis Brady, 1884 Rep. Voy. Challenger. Zoology, vol. 9, p. 273, pl. 27, figs. 12-15. Gooday, 1983 figs. 11, 12.
Dark, irregular ramifying tube with multiple apertures. Wall thin, comprised of fine quartz grains with occasional larger grains over a black organic lining. Rare. Traditionally listed with Foraminifera, Gooday and Nott (1982) have shown that this species is actually a Xenophyophore.

Hormosina globulifera Brady

Pl. 5, fig. 7

Hormosina globulifera Brady, 1879 Quart. Jour. Micr. Sci. vol. 19, p. 60, pl. 4, figs. 4, 5. Mendelson, 1982 pl. 4.
Test large, yellow in color, with globular chambers, rapidly increasing in size.

Hormosina sp.

Pl. 5, fig. 8

Small, reddish-brown in color, usually 2 or 3 chambers.

Hormosinella distans (Brady)

Pl. 5, fig. 9

Lituola (Reophax) distans Brady, 1881 Quart. Jour. Micr. Sci. vol. 21, p. 50.

Reophax distans Brady. Barker, 1960 pl. 31, figs. 18, 19.
Test thin-shelled, most commonly broken into single chambers, colored brown. May incorporate larger quartz grains. Stschedrina (1969) designated R. distans the type species for Hormosinella. Saidova (1970) assigned this species as the genotype for Cadminus, which is considered a junior synonym herein.

Reophanus oviculus (Brady)
Pl. 5, fig. 10

Hormosina ovicula Brady, 1879 Quart. Jour. Micr. Sci. vol. 19, p. 61, pl. 4, fig. 6.
Reophanus oviculus (Brady). Mendelson, 1981 pl. 5.
Test slender, finely agglutinated, several grains thick at apertural neck, yellowish to brown in color. Placed in Reophanus Saidova, 1970 by Saidova (1975), which supposedly differs from Reophax in possessing extended apertural ends of chambers which are embraced by successive chambers. Mendelson (1981) upheld the generic designation Reophanus, maintaining that the chambers do not embrace, but it differs from Hormosina in possessing a long apertural neck.

Subreophax adunca (Brady)
Pl. 6, fig. 1, 2

Reophax adunca Brady, 1882 Proc. Roy. Soc. Edinburgh. vol. 11, no. 111, p. 715.
Subreophax adunca (Brady). Saidova, 1975 pl. 11, fig. 6.
Non-rectilinear flexible test with globular chambers. Wall brownish-grey in color. Saidova (1975) assigned this species as the genotype for Subreophax, which differs from Reophax in its sinuous test and compressed chambers. The generic designation was upheld by Loeblich and Tappan (1982).

Reophax agglutinatus Cushman
Pl. 6, fig. 2. Pl. 6, fig. 3

Reophax agglutinatus Cushman, 1913 U.S. Nat. Mus. Proc. vol. 44, p. 637, pl. 79, fig. 6.
Test large, containing 2-4 chambers, possessing a pelitic wall with agglutinated small planktonic foraminiferal tests.

Reophax bacillaris Brady

Pl. 6, fig. 4

Reophax bacillaris Brady, 1881 Quart. Jour. Micr. Sci. vol. 21, p. 49 Cole, 1981 pl. 2, fig. 12.

Test large, gently curved, coarsely agglutinated, with sponge spicules. Found only at HEBBLE Shallow Site (4185 m depth). Placed in Pseudonodosinella by Saidova (1970).

Reophax bilocularis Flint

Pl. 6, figs. 5, 7, 8

Reophax bilocularis Flint, 1899 U.S. Nat. Mus. Ann. Rep., 1897, pt. 1, p. 273, pl. 17, fig. 2. Hofker, 1972 pl. 9, figs. 3, 4.

Test large, comprised of small planktonic foraminiferal tests and occasional sand grains. Aperture on a produced neck built of minute clear-white quartz fragments.

Reophax dentaliniformis Brady

Pl. 6, fig. 9

Lituola (Reophax) dentaliniformis Brady, 1881 Quart. Jour. Micr. Sci. vol. 21, p. 49.

Reophax dentaliniformis Brady. Barker, 1960 pl. 30, fig. 21.

Slender, elongate test comprised of clear quartz grains. Chambers globular, aperture small, on a produced neck.

Reophax dentaliniformis Brady var. 1

Pl. 6, fig. 10

Differs from typical R. dentaliniformis in its more straight-sided test and wider aperture. Not found at the HEBBLE Shallow Site.

Reophax dentaliniformis Brady var. 2

Pl. 6, figs. 6, 11

Differs from R. dentaliniformis var. 1 in utilizing small planktonic foraminifera in the construction of its test.

Reophax gracilis (Kiaer)

Nodulina gracilis Kiaer, 1900 Norweg. Fish Mar. Invest., Rept.,

Kristiania vol. 1, no. 7, p. 24, text-figs. 1, 2.
Reophax gracilis (Kiaer). Cole, 1981 pl. 16, fig. 25.
Rare, very delicate, fine grained species, yellow in color.

Reophax nodulosa Brady
Pl. 6, fig. 12

Reophax nodulosa Brady, 1879 Quart. Jour. Micr. Sci. vol. 19, p. 52, pl. 4, figs. 7,8. Barker, 1960 pl. 31, figs. 6-9.
Robust brownish test with finely agglutinated, finely finished wall. Type species for Pseudonodosinella Saidova (1970), which differs from Reophax in having 3-4 costae at base of chamber interior. Not found at the HEBBLE Shallow Site.

Reophax pilulifer Brady
Pl. 7, figs. 1, 2

Reophax pilulifer Brady, 1884 Rep. Voy. Challenger. Zoology, vol. 9, p. 292-293, pl. 30, figs. 18-20. Barker, 1960 pl. 30, figs. 18-20.
Test robust, yellow in color, comprised of coarse sand grains with occasional small planktonic foraminifera and pelitic material.

Reophax scorpiurus Montfort
Pl. 7, fig. 3

Reophax scorpiurus Montfort, 1808 Conch. Syst., vol. 1, p. 330 83me genre. Barker, 1960 pl. 30, fig. 16.
Test clear-white, coarsely arenaceous with few chambers.

Reophax sp. 1
Pl. 7, figs. 4, 5

Test increases rapidly in size, chambers flask-shaped, comprised of a single layer of clear-white quartz grains, usually found as monolocular fragments.

Reophax sp. 2
Pl. 7, fig. 6

Test minute, reddish-brown in color, coarsely agglutinated. Differs from Hormosina sp. in possessing less embracing chambers.

?Hormosina guttifer (Brady)

Pl. 7, fig. 7

Lituola (Reophax) guttifer Brady, 1881 Quart. Jour. Micr. Sci. vol. 21, p. 49.

Reophax guttifer (Brady). Barker, 1960 pl. 31, figs. 10-15.

Brownish test with overlapping pyriform chambers. Test wall made of sand grains of various size, typically one layer thick. Saidova (1970) placed this species in Reophanus.

Family LITUOLIDAE de Blainville, 1825

Haplophragmoides sp.

Pl. 7, fig. 8

Minute planispiral, finely agglutinated test with 4 1/2 chambers in last whorl, brown in color.

Adercotryma glomerata (Brady)

Pl. 7, figs. 9, 10

Lituola glomerata Brady, 1878 Ann. Mag. Nat. Hist. ser. 5, vol. 1, p. 433, pl. 20, fig. 1.

Adercotryma glomerata (Brady). Barker, 1960 pl. 34, figs. 15-18.

Small, brownish test with high chambers.

Cribrostomoides rotulatum (Brady)

Lituola (Haplophragmium) rotulatum Brady, 1881 Quart. Jour. Micr. Sci. vol. 21, p. 50.

Cribrostomoides rotulatum (Brady). Barker, 1960 pl. 34, figs. 5, 6.

Test coarsely agglutinated, with deeply excavated umbilicus. Pl. 8, figs. 1a, b.

Cribrostomoides scitulum (Brady)

Pl. 8, figs. 2a, b

Lituola (Haplophragmium) scitulum Brady, 1881 Quart. Jour. Micr. Sci. vol. 21, p. 50

Cribrostomoides scitulum (Brady). Poag, 1981 pl. 11-12, fig. 4.

Smaller, more evolute and more numerous chambers than C. subglobosum. Test finely arenaceous, brownish-yellow, with open umbilicus.

Cribrostomoides subglobosum (G.O. Sars)

Pl. 8, figs. 3a, b

Lituola subglobosa G.O. Sars, 1871 For. Vid. Selsk. Christiana p. 253.
Cribrostomoides subglobosum (G.O. Sars). Poag, 1981 pl. 11-12, fig. 2.
A robust species with 6 chambers in the last whorl.

Recurvoides contortus Earland

Pl. 8, fig. 5a, b

Recurvoides contortus Earland, 1934 Discovery Reports, Cambr. Univ. Press, vol. 10, p. 91, pl. 10, figs. 7-19. Resig, 1981 pl. 10, fig. 12.
The type species for Recurvoides, test light brown in color, early convolutions are inclined 90* to later convolutions, with about 7 chambers in the first plane, and 2 or 3 in the second. Common.

Recurvoides contortus Earland var.

Pl. 8, fig. 6

Differs from the typical in its greenish-yellow color and more finely agglutinated test with more cement.

Recurvoides turbinatus (Brady)

Pl. 8, fig. 4

Haplophragmium turbinatum Brady, 1881 Quart. Jour. Micr. Sci. vol. 21, p. 50. Cole, 1981 pl. 6, figs. 7, 8.
Test brown in color, with open umbilicus. Later convolution inclined only slightly to previous one. More finely agglutinated than R. contortus.

Cystammina pauciloculata (Brady)

Pl. 9, fig. 1

Trochammina pauciloculata Brady, 1879 Quart. Jour. Micr. Sci. vol. 19, p. 58, pl. 5, figs. 13, 14.
Cystammina pauciloculata (Brady). Ingle et al., 1980 pl. 9, fig. 11.
Test brown in color, rare. Placed in the family Lituolidea by Brönnimann et al. (1983).

Cystamminella galeata (Brady)

Pl. 9, fig. 2a, b

Trochammina galeata Brady, 1881 Quart. Jour. Micr. Sci. vol. 21, p. 52.
Cystamminella galeata (Brady). Lukina, 1980 fig. 47.
Wall finely agglutinated, finely finished, dark brown. Designated by Lukina (1980) as the type species for Cystamminella, which differs from Cystammina in possessing a planispiral involute test with a peripheral aperture. Not found at the HEBBLE Shallow Site.

Cystamminella ringens (Brady)

Pl. 9, fig. 3a, b

Trochammina ringens Brady, 1979 Quart. Jour. Micr. Sci., vol. 19, p. 57, pl. 5, fig. 12a,b.
Cystamminella ringens (Brady). Lukina, 1980 fig. 48.
Color brown, very smoothly finished test, 3 chambers in the last whorl, aperture an areal slit. Rare.

Ammobaculites agglutinans (d'Orbigny)

Pl. 9, fig. 4

Spirolina agglutinans d'Orbigny, 1846 Foram. Foss. Vienne, p. 137, pl. 7, figs. 10-12.
Ammobaculites agglutinans (d'Orbigny). Resig, 1981 pl. 9, fig. 16.
Robust, coarsely agglutinated test, pooly cemented. Test larger and thicker than A. americanus, with wider uniserial part. Found only at HEBBLE Shallow site (4185m).

Ammobaculites cf. americanus Cushman

Pl. 9, fig. 5

Ammobaculites americanus Cushman, 1910. U.S. Nat. Mus. Bull. no. 71, pp. 117-118, text figs. 184, 185.
Test thin, coarsely agglutinated, with dark mafic grains, spiral part in 2 whorls, uniserial part usually absent, delicate and thin. Differs from the typical in the more slender uniserial part. Abundant.

Ammomarginulina foliacea (Brady)

Pl. 9, fig. 6

Lituola (Haplophragmium) foliacea Brady, 1881 Quart. Jour. Micr. Sci. London, vol. 21, p. 50.

Ammomarginulina foliacea (Brady). Cole, 1981 pl. 5, fig. 4.

Test finely agglutinated, very thin, almost black in color, with many biotite flakes and mafic grains. Uniserial part broad, with arched septa. Spiral part in 1 whorl, broader than uniserial part.

Family LOFTUSIIDAE Brady, 1884

Cyclammina cancellata Brady

Pl. 10, figs 1a, b, 2, 3

Cyclammina cancellata Brady 1979 Quart. Jour. Micr. Sci., vol. 19, p. 62.

Biconvex, compressed planispíral test with approx. 13 chambers in the last whorl. Reddish or yellowish brown in color and typically poorly preserved. Both megalosphaeric and microsphaeric forms present.

Family TEXTULARIIDAE Ehrenberg, 1838

Textularia cf. flintii Cushman

Pl. 9, fig. 7

Textularia flintii Cushman, 1911 U.S. Nat. Mus. Bull. 72, vol. 2, p. 21, figs. 36a,b.

Very robust fine-grained test with wide interiomarginal aperture, grey in color. Rare.

Family TROCHAMMINIDAE Schwager, 1877

Trochammina globigeriniformis (Parker and Jones)

Pl. 10, fig. 5a, b

Lituola nautiloidea Lamarck var. globigeriniformis Parker and Jones, 1865 Roy. Soc. London Philos. Trans. vol. 155, p. 407, pl. 15, figs. 46, 47.

Trochammina globigeriniformis (Parker and Jones), Poag, 1981 pl. 13-14, fig. 1.
Robust species with four chambers visible on the umbilical side.

Trochammina cf. macrescens Brady

Trochammina macrescens Brady, 1870 Ann. Mag. Nat. Hist. ser. 4, vol. 6, p. 51, pl. 11, figs. 5 a-c.
Rare species, compressed, with 2 whorls on spiral side, brown in color.

Trochammina pygmaea Höglund

Pl. 10, fig. 7

Trochammina globigeriniformis (Parker et Jones) var. pygmaea Höglund, 1947 p. 200, text-fig. 182, pl. 17, fig. 3.
Test smaller, yellowish in color, with fewer chambers in last whorl than T. globigeriniformis. Finely agglutinated with many mafic grains.

Trochammina soldanii Earland

Pl. 11, fig. 4a, b

Trochammina soldanii Earland, 1936 Discovery Reports vol. 8, p. 38, pl. 1, figs. 32-34.
Robust, coarsely agglutinated, yellowish test with earlier whorls sometimes darker in color. Five chambers are visible on the ventral side. Aperture interiomarginal surrounded by a thin rim.

Portatrochammina eltaninae Echols

Pl. 10, figs. 4, 6a, b

Portatrochammina eltaninae Echols, 1971 Antarctic Res. ser. 15, p. 148, pl. 8, fig. 1, 2.
Test attached or free, brown in color, with 5 chambers in the last whorl.

?Conotrochammina bullata (Höglund)

Pl. 11, figs. 1, 2, 3

Trochamminella bullata Höglund, 1947 pp. 213-214, pl. 17, fig. 5.
Conotrochammina bullata (Höglund). Echols, 1971 pl. 5, fig. 11, 12.

Test small, conical, initial chambers brownish-red in color, 4 to a whorl, latter chambers lighter in color or white, 3 to a whorl. Aperture umbilical. Brönnimann et al. (1983) consider Conotrochammina nomen dubium.

Family VULVULINIDAE Berthelin, 1880

Eggerella bradyi (Cushman)

Pl. 11, fig. 5

Verneuilina bradyi Cushman, 1911 U.S. Nat. Mus. Bull. 71, pt. 2, p. 54, test fig. 87a, b. pl. 6, fig. 4.

Eggerella bradyi (Cushman). Barker, 1960 pl. 47, 4-7.

Robust, very fine-grained, greyish-white in color.

Eggerella propinqua (Brady)

Pl. 11, fig. 6

Verneuilina propinqua Brady, 1884 Rep. Voy. Challenger, Zool. vol. 9, p. 387, pl. 47, figs. 8-12.

Eggerella propinqua (Brady). Barker, 1960 pl. 47, fig. 8-12.

Robust, coarse-grained with some dark mafic grains, brown in color.

Karreriella apicularis (Cushman)

Pl. 11, fig. 7.

Gaudryina apicularis Cushman, 1911 U.S. Nat. Mus. Bull. 71, pt. 2, p. 69, figs. 110a,b.

Karreriella apicularis (Cushman). Poag, 1981 pl. 15-16, fig. 5.

Test minute, dark brown in color, with twisted biserial part.

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Plates

Plate 1.

Fig. 1.	?Astrammina sphaerica Heron-Allen and Earland var.	X 40
Fig. 2.	Rhabdammina cf. abyssorum Carpenter	X 50
Fig. 3.	Rhabdammina discreta Brady	X 85
Fig. 4.	Rhabdammina linearis Brady	X 40
Fig. 5.	Rhizammina cf. algaeformis Brady	X 40
Fig. 6.	Rhizammina indivisa Brady	X 40
Fig. 7.	Bathysiphon cf. filiformis M. Sars	X 35
Fig. 8.	Bathysiphon cf. rufescens Cushman	X 35

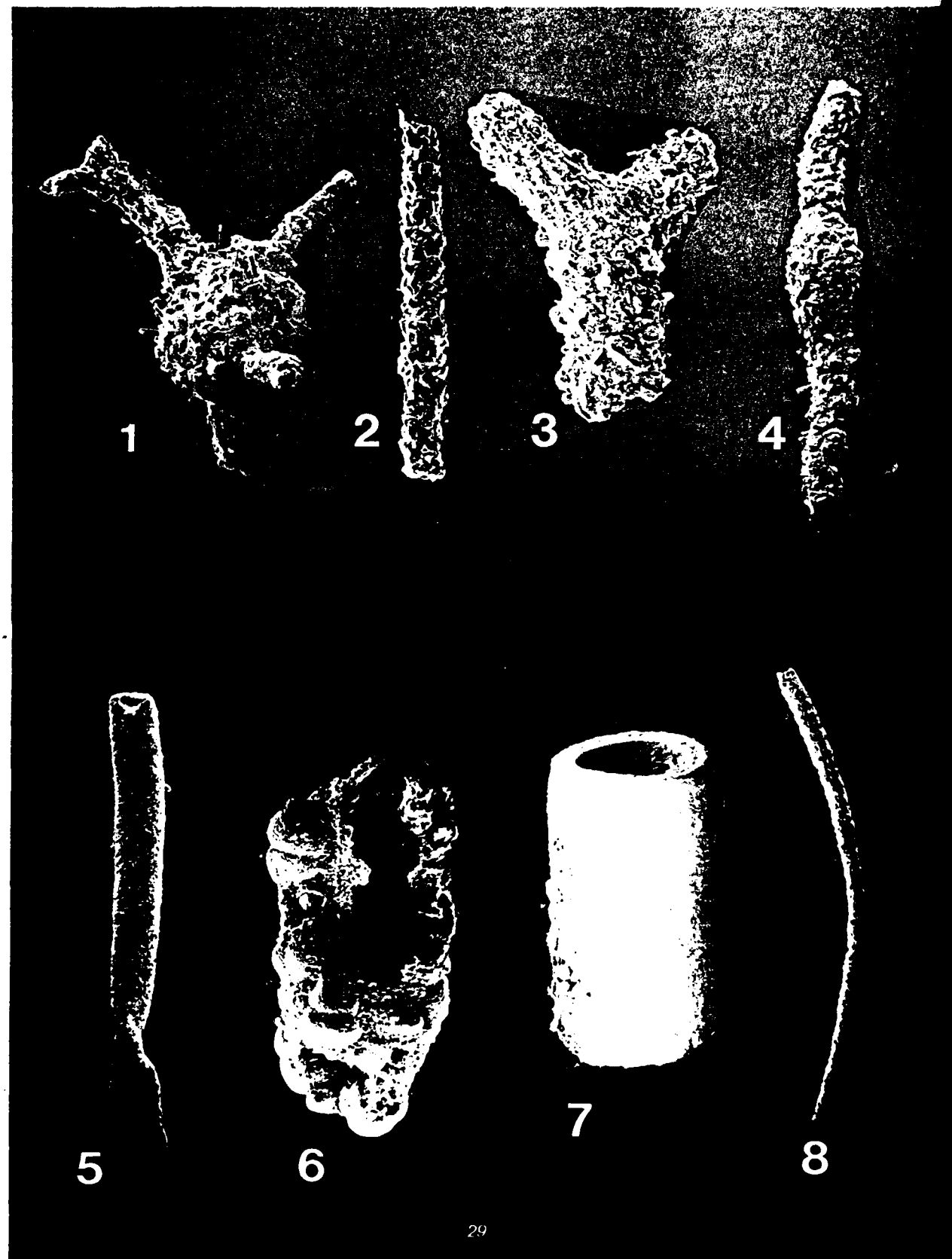

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Plate 2

Fig. 1.	Marsipella cylindrica Brady. Abraded specimen showing inner lining	X 200
Fig. 2.	Hyperammina cylindrica Parr	X 50
Fig. 3.	Hyperammina elongata Brady	X 50
Fig. 4.	Hyperammina friabilis Brady	X 25
Fig. 5.	Hyperammina cf. subnodosa Brady	X 50
Fig. 6.	Hyperammina sp.	X 75
Fig. 7.	Saccorhiza ramosa (Brady)	X 45
Figs. 8, 9.	?Saccorhiza sp.	X 50
Fig. 10.	Botellina labrynthica Brady	X 50

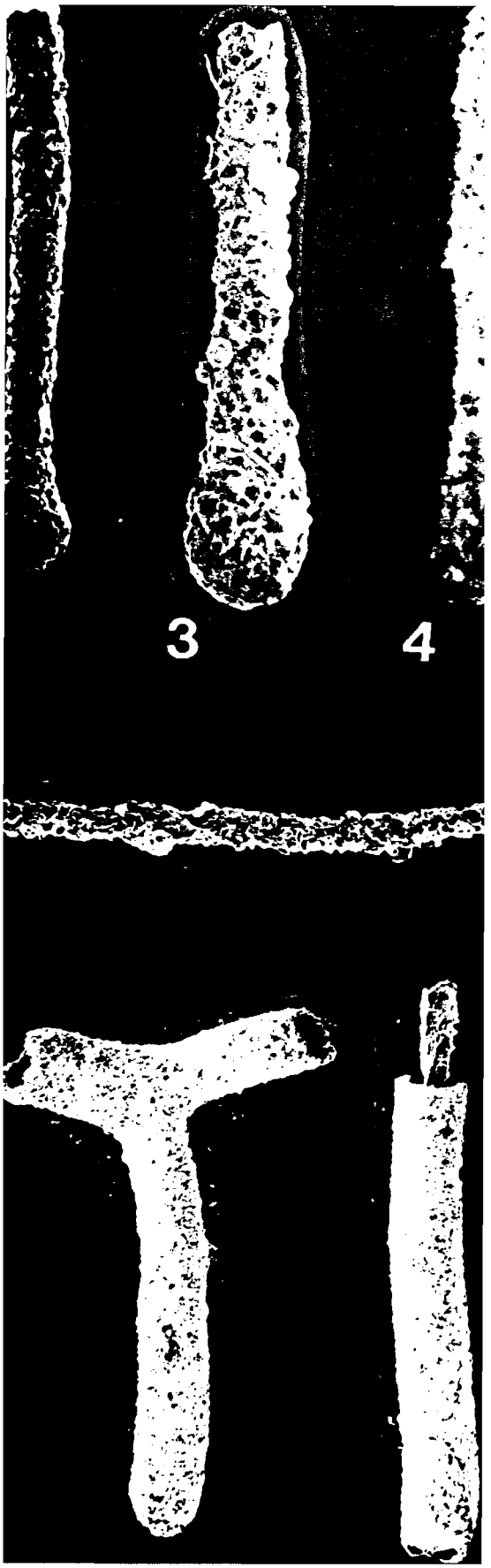
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Plate 3

Fig. 1.	Psammosphaera cf. fusca Schultze	X 85
Fig. 2.	Psammosphaera cf. fusca Schultze	X 100
Fig. 3.	Psammosphaera parva Flint	X 100
Fig. 4.	Psammosphaera sp.	X 170
Fig. 5.	Psammosphaera sp. Specimen with agglutinated planktonic foraminifer and P. cf. fusca test.	X 100
Fig. 6.	Psammosphaera testacea (Flint)	X 100
Fig. 7.	Saccammina sphaerica G.O. Sars	X 200
Fig. 8.	Saccammina tubulata Rhumbler	X 100
Fig. 9.	Thurammina papillata Brady	X 100

Plate 4

Fig. 1.	*Septuma ocotillo* Tendal and Hessler	X 25
Fig. 2.	*Lana reticulata* Tendal and Hessler	X 25
Fig. 3.	*Septuma* sp.	X 25
Fig. 4.	*Septuma* sp.	X 75
Figs. 5, 6.	*Lana* sp.	X 25

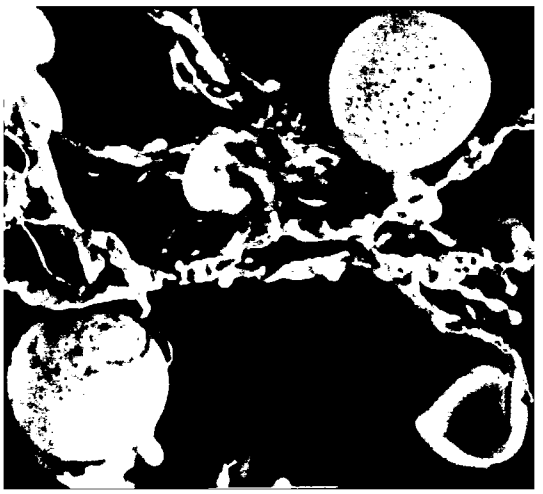

Plate 5

Fig. 1.	Glomospira charoides (Jones and Parker)	X 250
Fig. 2.	Glomospira gordialis (Jones and Parker)	X 375
Fig. 3.	Aschemonella scabra Brady	X 25
Fig. 4.	Aschemonella scabra Brady	X 50
Fig. 5, 6.	Aschemonella ramuliformis Brady	X 50
Fig. 7.	Hormosina globulifera Brady	X 60
Fig. 8.	Hormosina sp.	X 120
Fig. 9.	Hormosinella distans (Brady)	X 75
Fig. 10.	Reophanus oviculus (Brady)	X 100

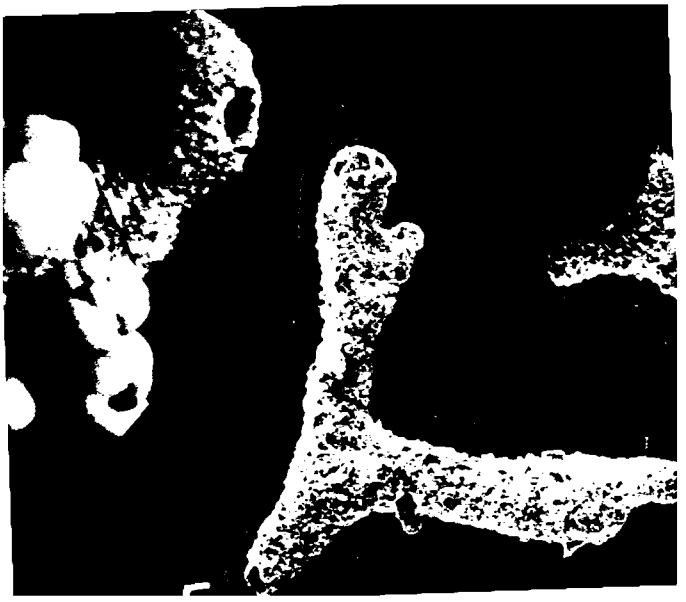

Plate 6

Fig. 1,	- *Subreophax adunca* (Brady)	X 80
Fig. 2,	*Subreophax adunca* (Brady)	X 50
Fig. 3.	*Reophax agglutinatus* Cushman	X 25
Fig. 4.	*Reophax bacillaris* Brady	X 50
Fig. 5.	*Reophax bilocularis* Flint	X 50
Fig. 6.	*Reophax dentaliniformis* Brady var. 2	X 25
Fig. 7.	*Reophax bilocularis* Flint	X 25
Fig. 8.	*Reophax bilocularis* Flint	X 25
Fig. 9.	*Reophax dentaliniformis* Brady	X 100
Fig. 10.	*Reophax dentaliniformis* Brady var. 1	X 80
Fig. 11.	*Reophax dentaliniformis* Brady var. 2	X 100
Fig. 12.	*Reophax nodulosa* Brady	X 75


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Plate 7

Fig. 1.	Reophax pilulifer Brady	X 50
Fig. 2.	Reophax pilulifer Brady (specimen with planktonic foraminifera incorporated into the test)	X 60
Fig. 3.	Reophax scorpiurus Montfort	X 70
Fig. 4.	Reophax sp. 1	X 75
Fig. 5.	Reophax sp. 1	X 85
Fig. 6.	Reophax sp. 2	X 250
Fig. 7.	?Hormosina guttifer (Brady)	X 100
Fig. 8.	Haplophragmoides sp.	X 250
Figs. 9, 10.	Adercotryma glomerata (Brady)	X 250

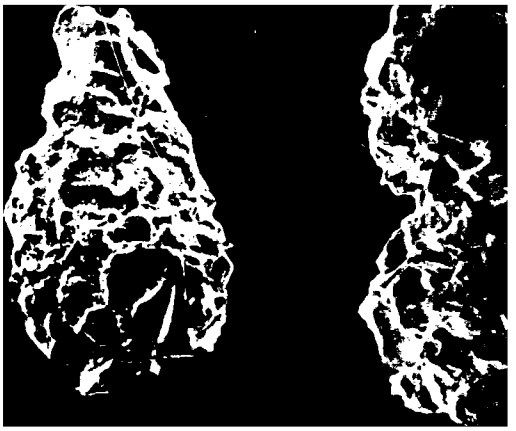


Plate 8

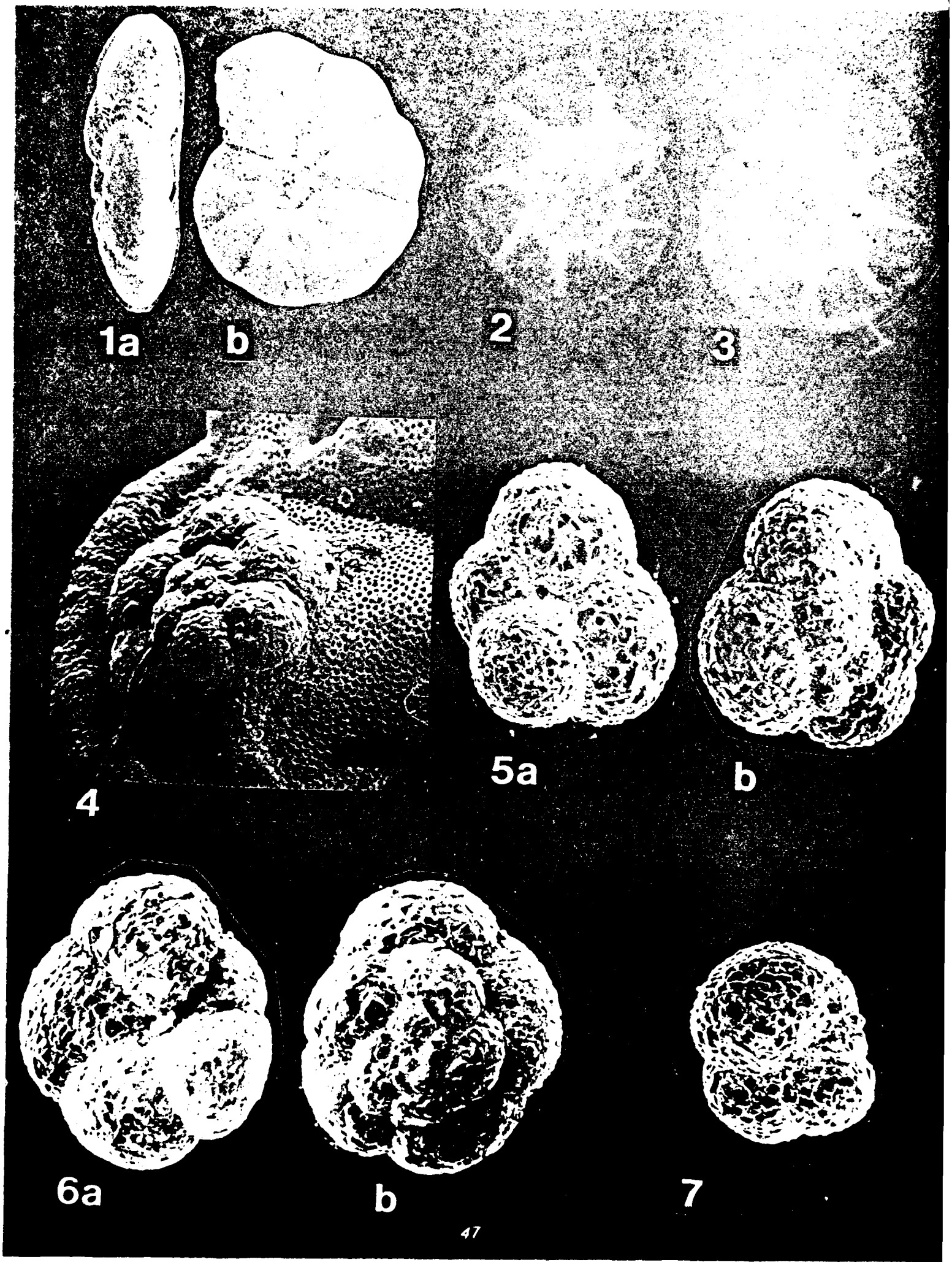
Figs. 1a, b.	Cribrostomoides rotulatum (Brady)	X 80
Figs. 2a, b.	Cribrostomoides scitulum (Brady)	X 80
Figs. 3a, b.	Cribrostomoides subglobosum (G.O. Sars)	X 80
Fig. 4.	Recurvoides turbinatus (Brady)	X 75
Figs. 5a, b.	Recurvoides contortus Earland	X 80
Fig. 6.	Recurvoides contortus Earland var.	X 160

Plate 9

Fig. 1.	Cystammina pauciloculata (Brady)	X 160
Fig. 2a, b.	Cystamminella galeata (Brady)	X 120
Figs. 3a, b.	Cystamminella ringens (Brady)	X 100
Fig. 4.	Ammobaculites agglutinans (d'Orbigny)	X 50
Fig. 5.	Ammobaculites cf. americanus Cushman	X 75
Fig. 6.	Ammomarginulina foliacea (Brady)	X 125
Fig. 7.	Textularia cf. flintii Cushman	X 75

Plate 10

Figs. 1a, b.	Cyclammina cancellata Brady	X 120
Figs. 2, 3.	Cyclammina cancellata Brady. Contact X-radiograph images of microsphaeric and megalosphaeric specimens	X 100
Fig. 4.	Portatrochammina eltaninae Echols	X 250
Figs. 5a, b.	Trochammina globigeriniformis (Parker and Jones)	X 120
Figs. 6a. b.	Portatrochammina eltaninae Echols	X 200
Fig. 7.	Trochammina pygmaea Höglund	X 100


1a
b
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5a
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6a
b
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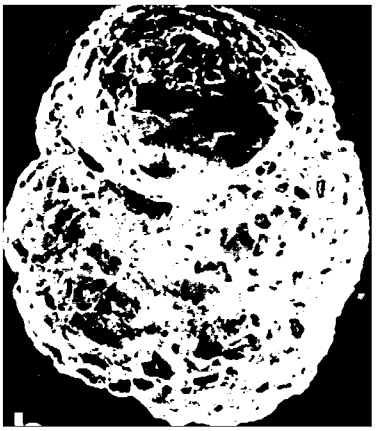
Plate 11

Fig. 1.	?Conotrochammina bullata Höglund	X 200
Fig. 2.	?Conotrochammina bullata Höglund Spiral side.	X 150
Fig. 3.	?Conotrochammina bullata Höglund Umbilical side.	X 150
Fig. 4a, b.	Trochammina soldanii Earland	X 100
Fig. 5.	Eggerella bradyi (Cushman)	X 200
Fig. 6.	Eggerella propinqua (Brady)	X 75
Fig. 7.	Karreriella apicularis (Cushman)	X 100
Fig. 8.	Placopsilinella aurantica Earland	X 250



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